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ABSTRACT

A useful device in revising technical reports is the metaphor of entropy, which refers to the amount of disorder that is present in a system. Applied to communication theory, high entropy would correspond to increased amounts of unfamiliar or useless information in a text. Since entropy in rhetorical systems increases with the unfamiliarity of content, the levels of abstraction, the ambiguities, and the density of relationships (the rate at which the reader is confronted with them), writers can reduce entropy by manipulating these variables. Using redundancies to help the receiver anticipate what will be said next, writers make what is said meaningful and understood. In technical reports, definition is a redundancy for the term defined; analysis is a redundancy for the structure under investigation; and description is a redundancy for the term described. The difficulty with making revisions is that excessive redundancy--too many revisions--tends to become noise, just as unfathomable information is noise. The critical balance between the factors that tend to increase entropy and the factors that writers use to reduce entropy can be expressed in the form of an equation. Writers can use such an equation as a guide for estimating the amount of entropy in their messages and the amount of revision that they should attempt. (RL)

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DISCOVERY AND ENTROPY IN THE REVISION OF TECHNICAL REPORTS

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In poetry and fiction and perhaps very personal essays, the reader is taken through the experiences of the writer and thus discovers meaning as the writer discovered it, by accumulation. In technical reporting, the meaning is stated, whether inductively or deductively, usually both, and the burden of composition is substantiating or reinforcing or rendering that meaning. After a draft has been completed - that is, after the writer has gone through the various revisions to get to an initial ending - he or she becomes a reader and may find the efforts at substantiating or reinforcing or rendering do not provide the desired effect, that the perceived order of things cannot be made convincing. In that event, the order must be changed to correspond with the possible generalizations, meanings, which can be substantiated. The image of order we have held in mind must change to suit ourselves as reader of ourselves.

The writing is the testing out of our generalizations, and the re-writing of the first draft is the rewriting of those generalizations, of our ordering and meaning. The writing and the rewriting are achieved

through the standard though ancient methods of description, narration, classification, analysis and so on, and with our mental models of effective style. In the rewriting process, however, these techniques of organization and style become more conscious; the writer can apply what he knows of them, making them more complete and more logical, or he can apply them to elaborate a point, which is always a means of testing the point. It is this conscious attention that we deliberately sacrifice in the first rush of invention. The experienced writer usually employs writing techniques by habit without specific awareness, but he nevertheless reapplies them in revision, while the less experienced will not have acquired writing techniques as habit and so will find much more to re-write and consequently discover in the process of revision.

In the revision process there is more to be discovered than meanings and the inseparable ways of rendering them. There is the matter of stylistic propensities. Does the writer tend to abstractions or concreteness? Does he avoid details or detail the obvious, which can be effectively communicated with a single abstract word? Is the tendency to successive long sentences, or short ones? Are the paragraphs series of periodic sentences, or loose ones? Or, as in so many technological reports, are complex sentences piled upon complex sentences, wearying and wearing the reader's ability to concentrate? Does the writer tend to digress or is there a stingy chariness? Is there a tendency to aggregate or segregate thought so that a paragraph extends over five manuscript pages or five paragraphs are set upon a single page?

And the patterns the writer habitually falls into? Is there a strong

inclination to the passive or an overexcited reliance on the active? An adherence to static description or the unrelieved activity of narration? Does the writer plunge on without summary or is there a maddening summation at the end of every few sentences, with the effect of two steps forward and one back? Is the writer's propensity monotonously deductive or inductive? Is there a tendency to define and exemplify even the obvious? Or nothing by way of definitive elaboration? Is there a habit of making images for the reader, rendering the feeling of things?

These questions of revision are of course the same questions we ask of writing. Once the writers can discern their propensities, they can either reinforce them or change them to achieve the effect they wish, of the ideal model of the writing in their minds. Of course, the writer must have read enough, be educated enough, to have a mental model of writing that will be effective to another. Awareness of the way a mental model has been realized will reveal the specific elements the writer must focus upon in the revising process.

While writers are still seeking order or meaning, they cannot devote full attention to the reader. Nor can they totally listen to themselves as readers if they are busy discovering propensities to style and form and consequently changing or developing thought and composition habits. The writer's full attention to the reader should also be a conscious act in itself, apart from all the previous writing activity. Once more the technical writer thinks differently than the poet or fiction writer who is often trying to express the inexpressible and whose communication is not intended to be a solid mental connection or even an emotional one.

Whatever the aim, it is seldom for the direct denotative strike at a singular meaning in the minds of a specific audience. Such writing is, according to most accounts, aimed at the writer's own image of his or her perceptions. The technical writer, however, is only useful when communicating with others whose minds and experiences may or may not resemble the writer's and who do not read for mere pleasure of esthetic delight or puzzle-solving. Although the great bulk of fiction and poetry in the past has also been referential and thus partially utilitarian, much of the literature of the twentieth century has been increasingly unavailable to twentieth century sensibilities. Often the technical writer, especially in the academics and the professions, acts in much the same way as the esthetic writer, forgetting the audience in a display of acuteness, vocabulary, and profundity. These writers may communicate with a handful of their colleagues, although printing hundreds, even thousands, of copies.

A useful device in revising technical reports is the metaphor of entropy. This metaphor promises a systematic means of reducing the reader's sense of disorder in the report allowing the writer's meaning to be perceived. A complex text dense with unfamiliar information is more likely to threaten than communicate with a reader. It can be considered a high entropy system, and the writer's object is to reduce the entropy. To do so, the writer must invade the system with new ordering energy, or negative entropy.

Originally, entropy was a thermodynamic metaphor but it has also been adapted to communications theory and is well established. In thermodynamics, the effort to reduce the entropy of a system - to make it more orderly -

is considered an unnatural process, and it must be accompanied by a natural process, which is the increasing of energy elsewhere, outside the system. The processes of nature compensate for the processes of mankind, which means that the tendency of the universe is always toward the human conception of disorder, which we naturally abhor. This aspect of entropy is ignored when applied to communications theory. Here, entropy is the measure of randomness in the information, which is a neat application of the thermodynamic definition of entropy as a measure of the random motion of molecules. Meaning in communications theory, is the ordering of information transmitted through a medium or channel. All bits of information in the channel which are not received or read as meaning become noises. If the receiver or reader of the information has a high degree of freedom in selecting its meaning, then the entropy is high, which means the information is largely noise; it is loosely organized or even shapeless. Literary works which aim at suggestion and ambiguity would be intentionally high entropy systems. Entropy increases not only with noise but with density of information, particles of possible meaning crowded in a channel at too high a rate for the receiver's decoding ability.

Entropy is combated, on the other hand, by redundancies, which allow the receiver to anticipate and thus make meaningful what will be said next. The more redundancy in a system, the more tolerance for noise. This theory obviously involves a good deal of counting and it may be of value in communications that aim at absolute denotation as in mathematical language. But even in a report, a genre of discourse forever fighting the connotative nature of language, there is usually the shaping of reason, a process

involving generalizations, abstractions, complex turns of thought. Even if these qualities could be counted, their values would change in each use; all subordinations, for instance, would not be equal. Unreasoned and uninterpreted, the accumulated bits of information become sheer noise for almost anyone except those who have gathered it. Communications theory has developed its metaphor most obviously from analogy with electronic systems where the random motion of electrons in conductors, transistors and the like, are indicators of disorder. Here the tendency to high entropy is always bad news and its reduction good. Applying the metaphor to rhetoric, however, high entropy may serve useful purposes, especially in literary works aiming at the representation of an ambiguous universe or intending a great deal of suggestiveness and wide connotation, or in phenomenology exercises. But in the process of revising technical reports, the writer should always seek to reduce the entropy.

The writer is the ordering force, the negative entropy invading the system which now consists of the text and the reader. Whether or not the process increases the writer's own entropy as a result of his input to the text-reader system is not significant in our use of the metaphor. A text may be by nature highly complex, difficult for pertinent readers and impossible for others; that is, the text and its audience may be by nature a highly entropic system. Many professional and sophisticated audiences might be bored if the text were not complicated enough to attract their lively attention, to offer them something new. Nevertheless, the writer in revising attempts to lower the entropy to the extent possible by simplifying the complex. Quite often, however, writers tend, for various

personal reasons, to raise the entropy by complicating the simple.

Use of the entropy metaphor in the revising process has a precedent in the popular eighteenth century rhetoric of Hugh Blair. He speaks of the relationship in a piece of rhetoric between the familiar and the strange. The proportions of these two factors in report, story, lyric, or what you will - the proportions or perhaps we may say ratio of the familiar to the strange determines the degree of order in the system. Blair does not talk about system, as do theorists in communications. The available information in a communications system consists of redundancies (the familiar) and new information (the strange). A high degree of redundancy counters or perhaps accommodates the new bits of information. I should say the rate at which the reader is given new items of information, but I prefer Blair's idea of the strange, since it is more rhetorical; it accounts for types and degrees of audience ability to read or understand, so that highly abstract words, or far-reaching metaphors are included with the concept being rendered to the reader. It includes whatever is unfamiliar. But Blair's idea of the strange, even though it is more inclusive than the idea of new information in communication theory, is still insufficient for an understanding of entropy in reports. In addition to a high density of diverse content and of abstract language, there is at least one more factor that works against the reader's ability to recreate the writer's meaning.

The additional factor is the density of relationships, such as ambiguities, coordinations, subordinations, modifications, and degrees of digression which would include associative processes, non-sequiturs, and other alogical juxtapositions. For rhetorical systems, therefore, we may

say that entropy increases with the unfamiliarity of content, the levels of abstractions, the ambiguities and the density of relationships (the rate at which the reader is confronted with them).

The ordering energy that the writer applies from outside his text-reader system in the process of revision must obviously render the unfamiliar familiar. It is done fundamentally by redundancies. The writer may repeat parts of complex sentences in order to make two or three new sentences, each with less density, or shape disparate ideas and observations by applying generalizations, or appeal to the reader's knowledge by particularizing generalization with familiar details, analogies or examples. The various devices of redundancy are the ways the writer delivers his meaning to the reader's understanding in all discourse, whether purely artistic or utilitarian. The rhythm, rhyme, assonance and alliteration of poetry are devices of redundancy. The use of motif and symbol in fiction as well as poetry are easily recognized redundancies. Character is established by a variety of repeated traits which set the type for the individuating surprises. Dominate moods and atmospheres also result from redundant elements in descriptions. Myth in all literature is redundancy that echoes through the centuries of a civilization. In technical reports, definition is a redundancy for the term defined; analysis is a redundancy for the structure under investigation; description is a redundancy for the term described. The idea of rendering is itself the idea of redundancy as opposed to statement. So is explanation with its various ways of saying one thing and of summarizing.

Noise, defined as meaningless information in communications systems,

is also a useful metaphor in the revision of rhetorical systems. Circumlocutions and cliches and excessive summary and the rendition of the obvious as in children's stories or in some television productions turn off the attention of a mature audience. They are all noise. But so are new items of information that remain unfamiliar and dense series of abstractions that also turn off the attention of mature audiences. These factors become noise because they frustrate and ultimately tire a reader who is always seeking meaning. Noise does increase the tendency to disorder but we cannot make it fit neatly into a definition of entropy unless we distinguish between meaningful and meaningless redundancy. We can settle this troublesome detail by recognizing the obvious - that excessive redundancy for a particular audience level tends to become noise just as unfathomable information is noise. In revision the writer is guided by his image of the audience as in all other aspects of the process.

The writer who revises without particular attention to noise may not realize how it annoys the reader, just as misspellings, awkwardness, and violation of anticipated grammatical construction annoy the reader. Noise inadvertently establishes its own tone and thus subverts the reader's perception of the writer's attitude. What may have been intended as sincerity comes across as pompous vacuity, or profound insight may be received as unschooled ignorance.

As with excessive redundancies, new relationships can also become noise - meaningless combinations of information. Yet the very point of relationship is to create meaning. Lists of contents are shaped by rela-

tionships such as predication, coordination, subordination, modification. But a high density of any form of these relationships without variety or reinforcement fails to accumulate into meaning. Instead of meaning, the high density tends to create another list of contents, each item a more or less meaningless complex of words. Abstractions and ambiguities are relationships in themselves and function as do all other relationships to establish meaning. Abstractions are generalizations that represent details; intended ambiguities are contradictory possibilities of meaning in a situation. Like the others, these relationships also become noise when presented in excessive density.

To adapt the metaphor of entropy efficiently to the revision of rhetorical systems, we can employ the single term "meaningful complexity" to represent all the factors that tend to abet disorder. We can then apply the term "meaningful redundancy" to the factors that the writer introduces to reduce the disorder. It becomes possible then to represent all the rhetorical factors in a single equation telling at once how the factors work to lower or raise entropy in the process of revision:

$$\text{Entropy equals } \frac{\text{meaningful complexity and noise}}{\text{meaningful redundancy}}$$

Although we can phrase such an equation, the application of numerical values would be disastrous. Entropy, we must remember, is a metaphor. It is a metaphor in thermodynamics and chemistry and a metaphor upon a metaphor in communications theory, where the idea of noise substitutes for the unavailable energy in a physical system, which is mathematically calculated, not empirically measured, and then is taken to represent the

tendency to disorder in that system. Our adaption of the metaphor to technical reporting is in terms of tendency, which must be felt rather than calculated because rhetorical systems are structures composed of kinds of relationships which are not perceived by counting.

Used qualitatively the entropy equation can guide the writer in ordering his critical sensibilities for the revision of technical reports. It may also lead to a better description of the nature of technical writing than we have had, and thus to more cogent means of analyzing any report whether established or in process.